



# MEGAWATT SOLID-STATE ELECTRONICS



# MCNC



**Dev Palmer**

MCNC Materials and Electronic Technologies Division

3021 Cornwallis Road

Research Triangle Park, NC 27709-2889

dpalmer@mcnc.org 919/248-1837 919/248-1455 FAX

<http://www.mcnc.org>

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## **MCNC Tasks**

- **Develop high-power packaging techniques for GaN devices**
- **Support UFI in device fabrication, assembly, and testing**
- **Produce a market study for solid-state power distribution and control**

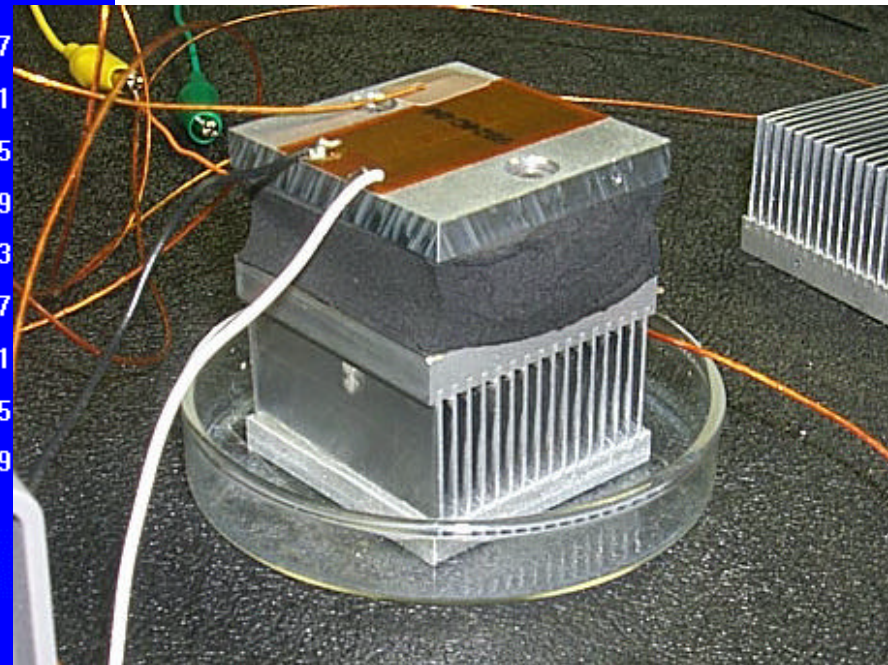
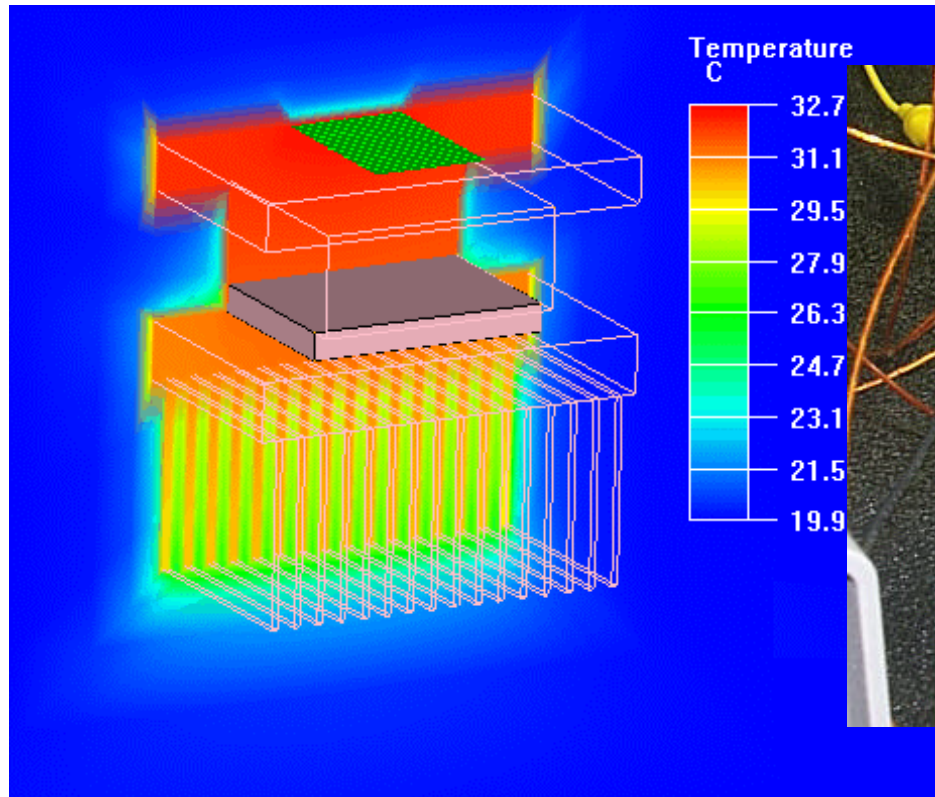


# **Packaging Task Progress**

- **Thermal imaging system selected out**
  - Expensive, not as flexible
  - Cannot detect internal temperatures
- **Thermal/mechanical simulation package purchased**
  - Icepak® (Fluent Software, Lebanon NH, 603/643-2600)
  - Electronics cooling application-specific
  - Imports common CAD file formats
  - Models radiation, conduction, and convection
  - Gives 3-D view of device/substrate/package temperature including internal temperatures
- **Technical staff trained**



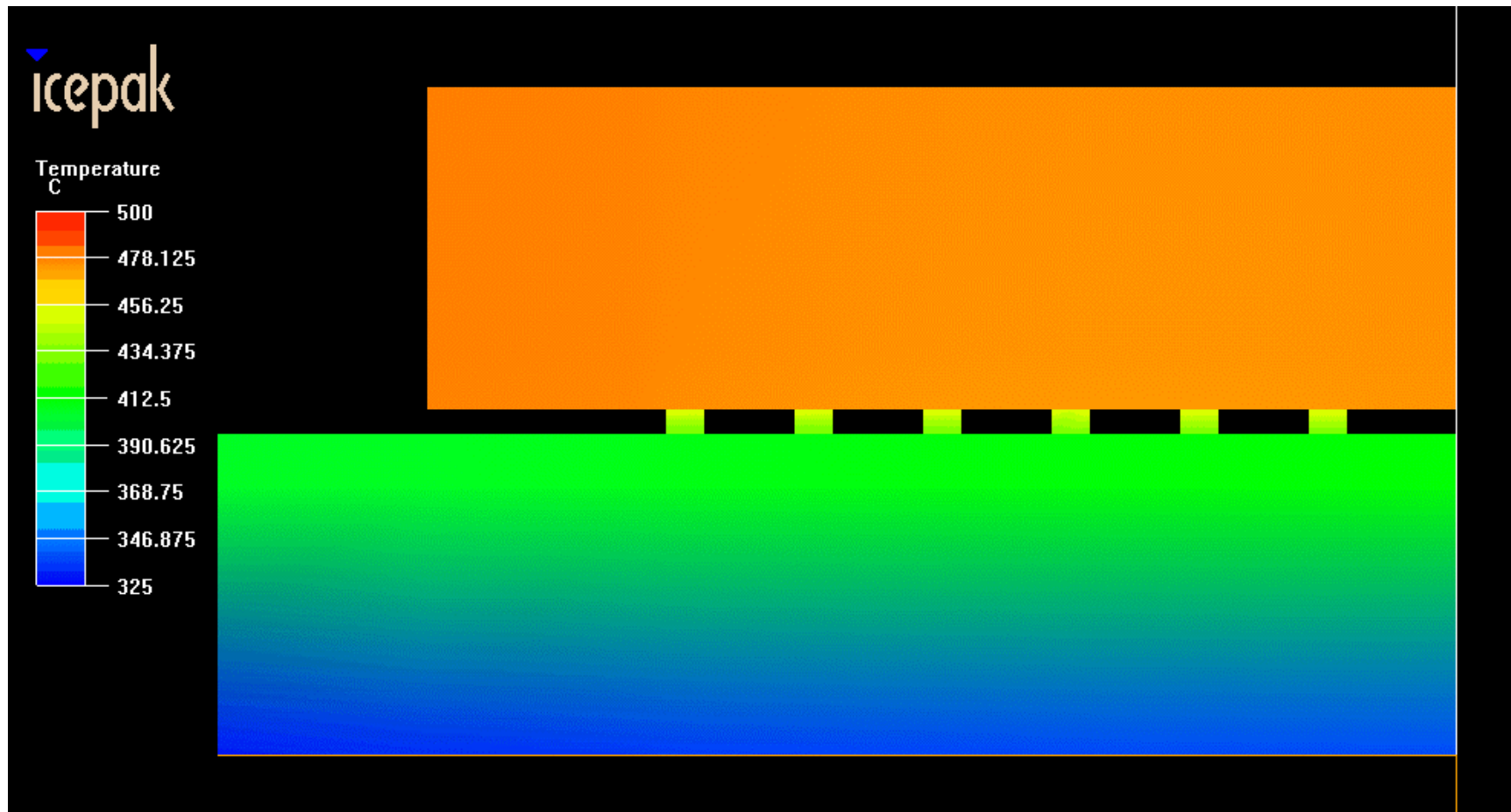
## Software Validation



Validate simulations by  
comparison with  
measurements



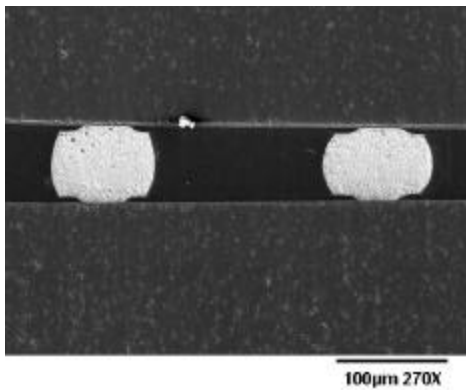
# Simulate GaN MESFET



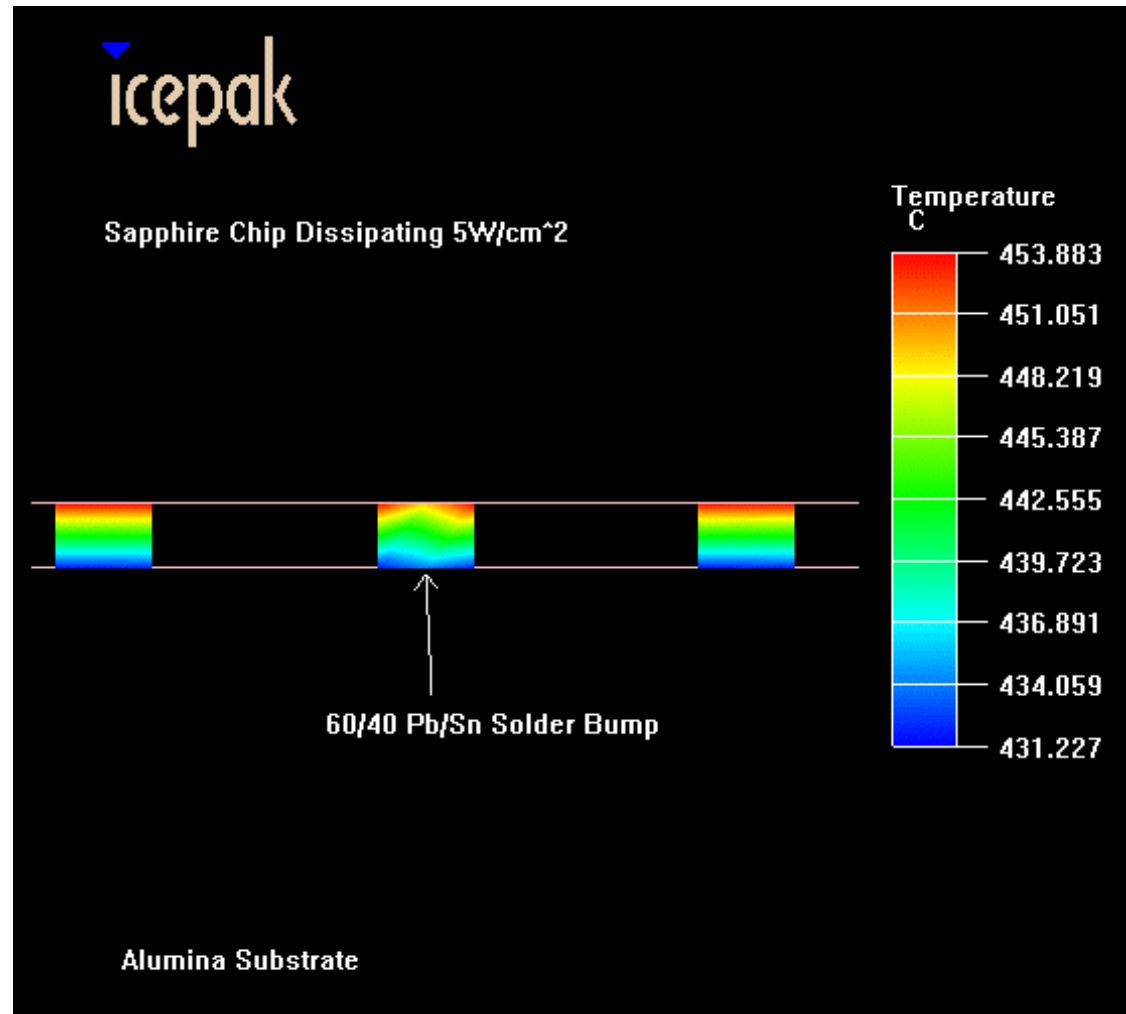




## Simulate Solder Bump Temperature



Successful  
meshing with  
realistic geometry



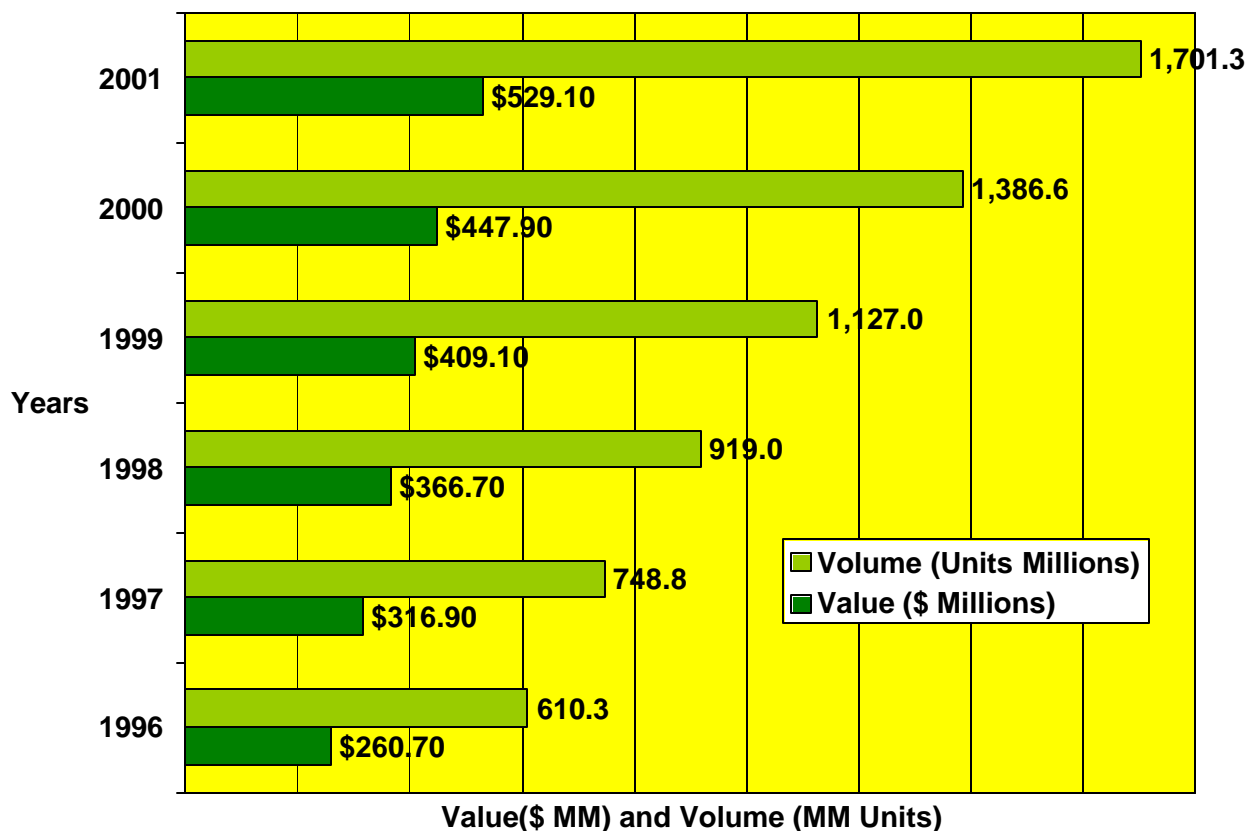


# **Market Study Task**

- **Market study complete**
  - Market data covering 1996 - 2000
  - Business data for 69 US companies
  - Business data for 127 non-US companies
  - List of 23 power electronics patents granted 1996 - 1999
  - Abstracts for 11 power electronics patents granted in 2000
- **Printed copies available at the front desk**
- **New study of electric power end-users initiated**
  - Determine R&D expenditures
  - Determine interest in innovative technologies



## Value and Volume of Thyristor Consumption (1996 – 2001)

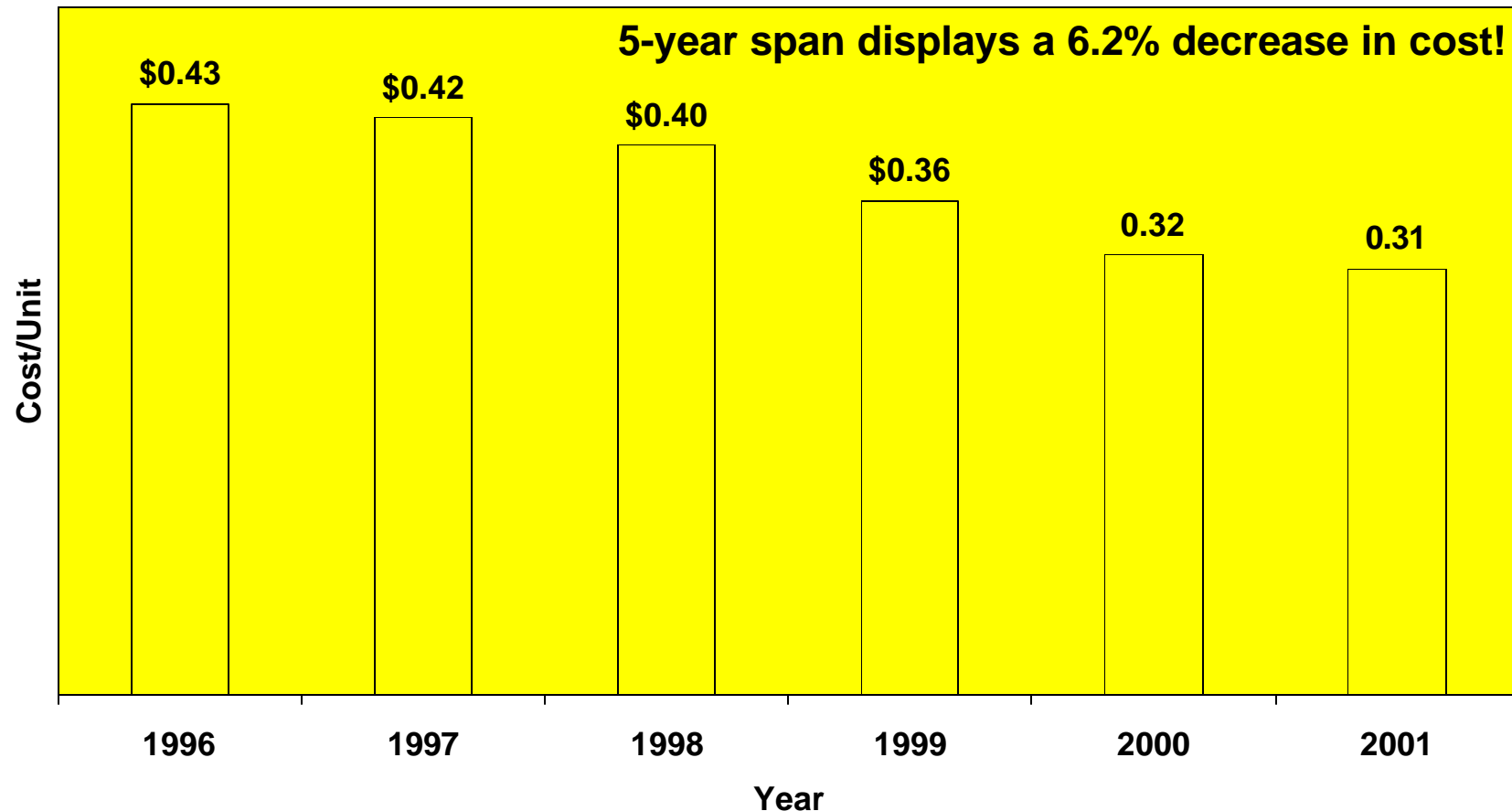


Source: Gas-Tubes, Diodes, Thermistors, Thyristors, and Varistors U.S. Markets, End-Users, and Competitors, 1996 – 2001 Analysis and forecasts, June 97 (World Information Technologies, Inc.)





## Average Selling Price of Thyristors (1996 – 2001)



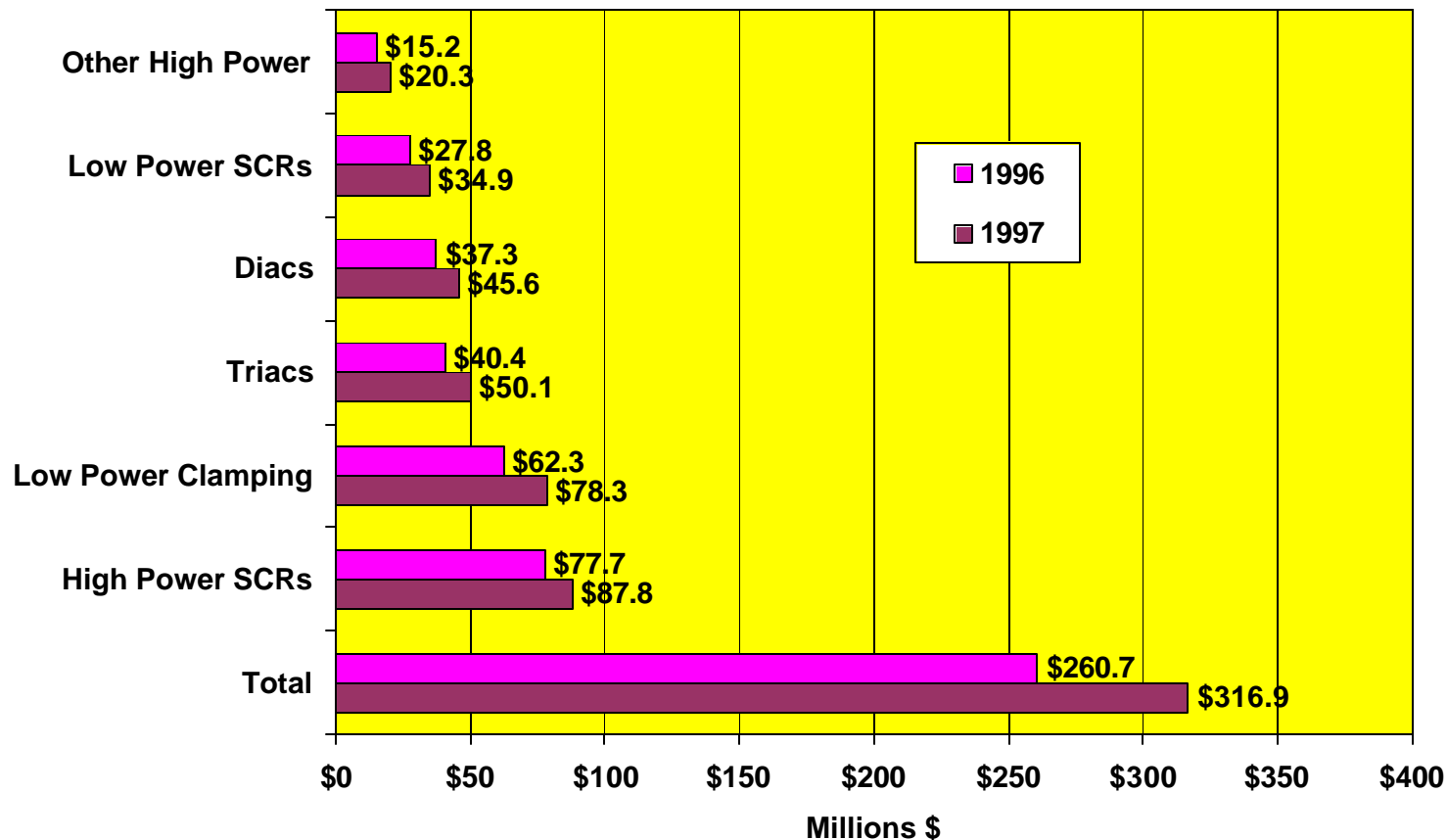
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### US Consumption of Thyristors by Type (\$Millions) 1996 and 1997

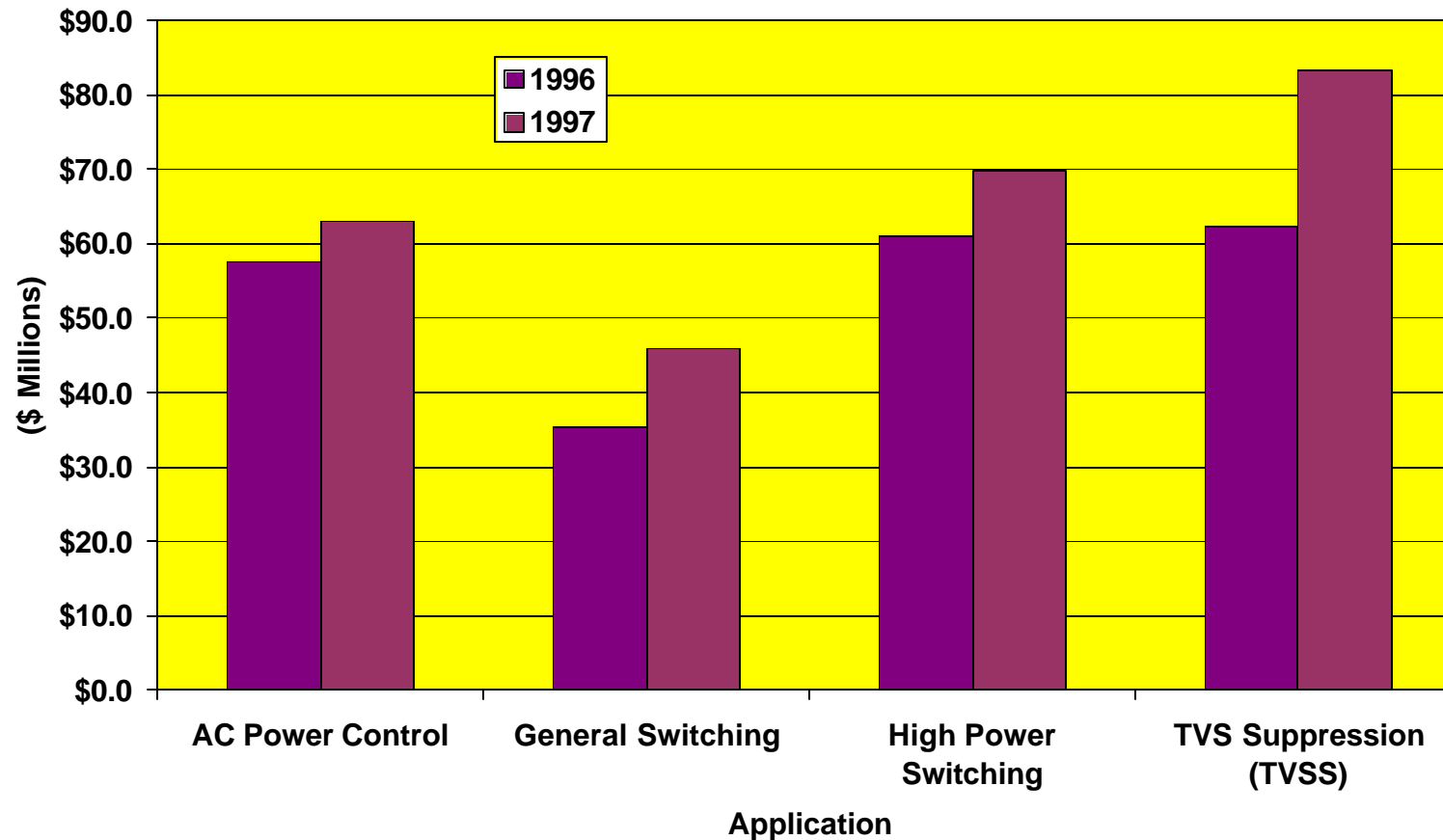


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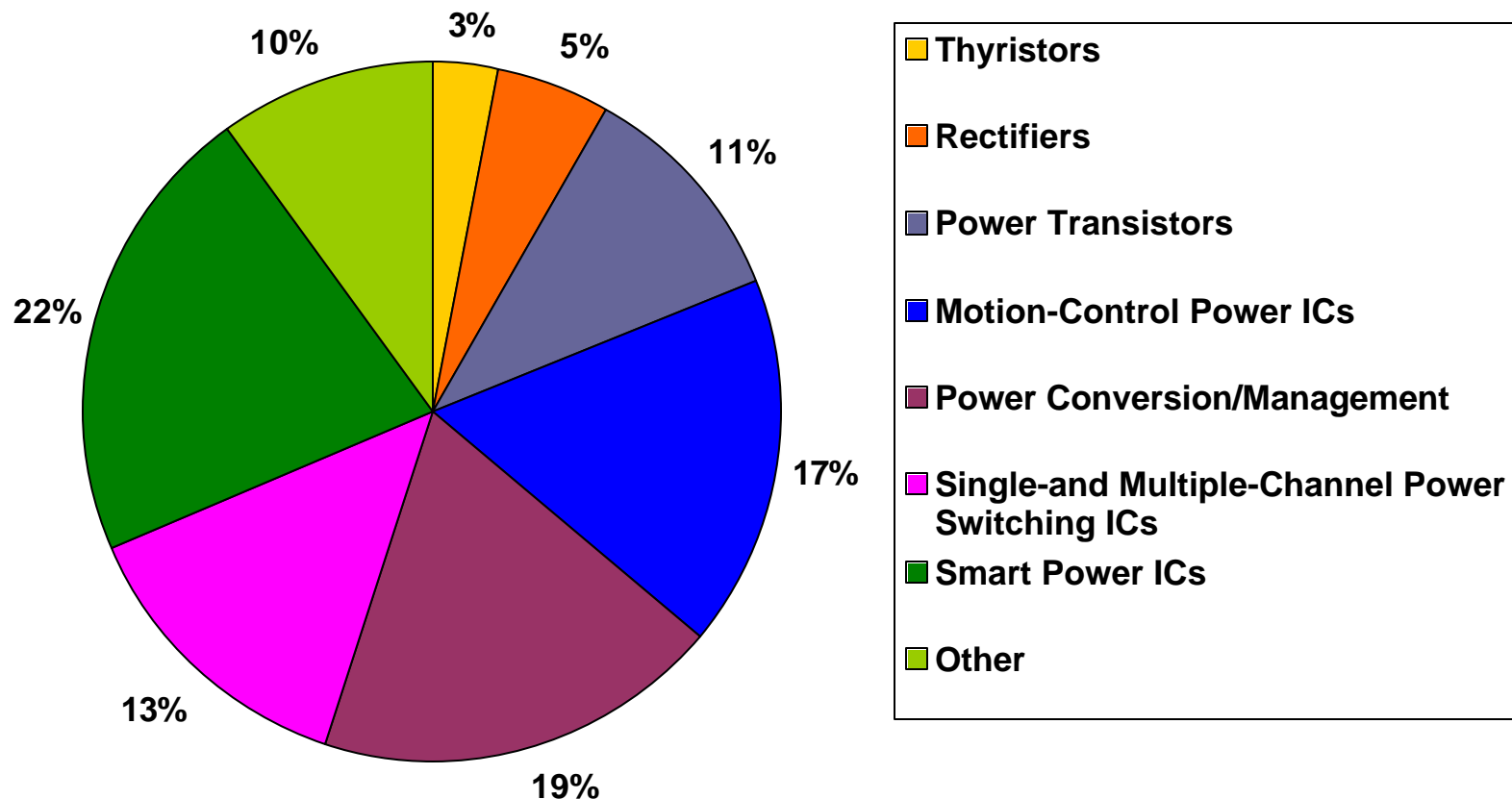
## Consumption of Thyristors by Application and Type (\$Millions) for 1996-1997



Source: Gas-Tubes, Diodes, Thermistors, Thyristors, and Varistors U.S. Markets, End-Users, and Competitors, 1996 – 2001 Analysis and forecasts, June 97 (World Information Technologies, Inc.)



## Industry Forecasts and Analysis for Current Annual Growth Rate (CAGR) from '96-'00



Source: Frost and Sullivan



## Future Work

- **Power packaging**
  - Verify software functionality by comparing simulation to measurements on COTS cooling stack
  - Evaluate GaN on bump on alumina package for MESFETs
  - Evaluate new substrate/package designs through simulation
- **Fabrication support**
  - Provide device fabrication, assembly, and testing as required
- **Market research**
  - Initiate study on power device end-users



# **Acknowledgments**

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